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SUBJECT:

HORSE SURRA.

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PREFACE.

THESE notes on Surra, put together in a handy form for convenience of reference, are abstracted from the report of Dr. Lingard, the Imperial Bacteriologist, and contain a résumé of the observations of Evans, Steel, Gunn, and others, together with the results of the work which has been done by the Imperial Bacteriologist during the last three years. Dr. Lingard has very kindly corrected the proof and added the supplemental note at page 29.

Information on all points connected with this disease is required, and should be given whenever possible. There is every reason to believe that Surra is a much more generally widespread disease that it at present appears; information of new centres is constantly being received, and it is feared that we do not at present know the extent of the losses to which it gives rise.

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MEERUT, 1894.

HORSE SURRA.

Definition.—Surra is a specific and continuous febrile disease occurring spontaneously in solipeds and camels, and capable of being transmitted by inoculation to other animals. It is due to the presence in the blood of an infusorian (*Trypanosoma Evansi*). It is chiefly met with in an epidemic form, during certain months of the year, *viz.*, between July and January. It is characterized by an intermittent, remittent, and sometimes by a relapsing type of fever, which continues for varying periods, according to the species and constitutions of animals attacked, and presents definite symptoms following each other in regular sequence. The chief symptoms, in addition to the peculiar febrile ones, are the occurrence of petechiæ or blood extravasations on the mucous membranes, chiefly those covering the membrana nictitans and the appearance of œdemata on the limbs, sheath and lower parts of the abdomen and chest, due to the exudation into the subcutaneous and other connective tissues of a yellow semi-gelatinous material. The animal rapidly loses condition and strength, although in the great majority of cases the appetite remains good throughout the whole course of the disease; indeed, it is remarkable to note that a patient will continue to feed during a paroxysm of fever, when its temperature is as high as 105° F.—a peculiarity not noted, so far as I am aware, in any other febrile disease of the horse. The visible mucous membranes first become pallid, and at a later period yellow or icteric. From first to last there is progressive anæmia; the blood at the commencement presents a normal appearance, but after a time undergoes marked changes. The white corpuscles increase in number and the red ones usually cease to form normal rouleaux, lose their individuality, and run together, forming irregular masses, which are at first dark, but, as the disease advances, almost entirely lose their colouring matter and become pale.

The presence of the infusorian in the blood is not continuous during the whole course of the disease. At first it is usually found in few numbers, and increases with greater or less rapidity, until, having attained a maximum, it disappears either gradually or suddenly to reappear after an interval. The periods during which it is present in, and absent from, the blood, are marked by extreme irregularity, varying from one to six days, but the latter period is very unusual. The disease is invariably fatal; death is generally due to

exhaustion, the result of anæmia, but it may occasionally be due to complications which arise in the course of the malady. After death no specific lesions are found on *post-mortem* examination.

HISTORICAL ACCOUNTS OF SURRA.

Our first knowledge of this disease was communicated by Evans, in a report dated November 1880, to the Government of India. The malady he designated "Surra," and defined it as a specific, parasitical, non-inflammatory, enzoötic blood disease, characterized by fever, jaundice, petechiæ of the mucous membrane, especially of the eye and vagina, dropsy, sometimes albumen in the urine, great prostration of strength and rapid wasting, and with a specific parasite in the blood during life; but no characteristic structural organic lesions are found after death. It may be transmitted by the subcutaneous injection of blood, and by drinking fresh blood containing the live parasites, but is not contagious or infectious in the ordinary way. The average duration of the disease is probably less than two months, but reliable statistics are wanting upon that point. Evans describes the invasion of the disease acquired in the ordinary way as that common to all low fevers. In a small majority of cases, the legs are swollen and œdematous; later a similar swelling is found between the fore legs of mares, or at the sheath of horses, and the animal is dropsical, there is great thirst, and the urine is high-coloured.

The conjunctival membranes become decidedly yellow in colour, with claret-coloured spots on the membranæ nictitantes. In the case of a mare the mucous membranes of the vagina are decidedly yellow, with petechiæ even more marked than in the eye. The duration of the disease is a difficult matter to settle, and depends on the constitution of the animal; weak animals succumb sooner. The progress of the disease is variable; the symptoms may sometimes subside, and again return worse than before; the most constant and invariable symptom in the progress of the disease is the wasting away of the flesh, and this is the more remarkable, seeing how much, and with what good appetite the patient eats. The wasting goes on more rapidly in some cases than in others. The record of the 4th Punjab Cavalry shows an average duration of forty-three days after the admission on the sick list; whether the animals die early or late, they are generally reduced in condition to mere living skeletons. There is often much anæmic palpitation of the heart in the last stage, and the membranes become blanched; some animals drop down and die suddenly, perhaps when eating, others become delirious and struggle on the ground, while other animals linger for days after they are helped up, but go on eating grass and corn until they die.

Evans noted a certain amount of clear serum in the peritoneal cavity, but no sign of any inflammatory action. In one case the pericardial sac was distended with fluid.

He says "that when he first saw the parasite, he thought for a moment it was some form of spirillum, but rapidly changed his mind on that point. It has an apparently round body when it is fresh and active, which tapers in front, forming a neck, ending in a blunt head, and behind it has a tapering tail, from which there extends a long slender lash, so fine that it can seldom be seen. It had two fin-like papillæ on each side, one pair placed near the neck, and one near the tail. He only occasionally saw the four at once, and they always appeared to occupy the same relative positions."

He describes the parasite as being wonderfully active, and presenting undulatory eel-like movements; it has the power of altering its shape, progressing almost always in the direction of the blunt end, though it is able to go in the reverse manner when pulling a corpuscle. He examined the kidneys, liver, spleen, heart, lungs, and the mucous lining of the stomach and intestines throughout, with great care, and stated positively that this disease is not characterized by any structural organic change; it is purely a disease of the blood. Petechiæ were noticed on the mucous lining of the intestines in some cases, but in no case was the structure of the liver diseased. The disease is absolutely fatal to horses, mules, and camels.

There is no evidence to show that the disease is either contagious or infectious in the ordinary sense; the weight of evidence is to the contrary. Seventy-seven horses of the 3rd Punjab Cavalry became affected at Jutta, and were taken to Edwardesabad, where all died, but did not communicate the disease to others. He considers that when horses are closely packed together, a large fly called "*burra-dhang*" may inoculate healthy animals with the blood of the diseased.

Evans submitted a puppy, inoculated with surra parasites transferred from the horse, to Dr. Lewis for his opinion. Lewis reported that "the parasites appeared to be very closely allied to the flaggellated variety, which were detected by himself in a considerable number of apparently healthy rats, but he could not then venture to express an opinion as to whether they were specifically identical."

Major Money, 4th Punjab Cavalry, stated that the disease was common amongst the horses of the 3rd Punjab Cavalry, when they obtained the grass from inundated ground near the River Indus, but it ceased when they got grass from higher ground. The outbreak takes place usually in August, but more in September, and continues until January, when it suddenly ceases.

Treatment.—The only form of treatment Evans tried was carbolic acid in glycerine (1 to 4), of which 219 drachms were administered during a period of 15 days, and still the organisms persisted in few numbers in the blood. The dose was then increased to 3 ozs. daily for a week, with no better result. He tried the same treatment with three other animals, but they all succumbed.

Steel, five years later, reported upon an outbreak in British Burma. The animals which he had to deal with, and which he made *post-mortem* examination on, were transport mules. He was much struck with the lesions found in the stomach, so provisionally termed the disease Gastric-typhoid fever of malarial origin; at a later date, when he had made careful thermometric observations, he came to the conclusion that the disease must be regarded as a true relapsing fever, closely resembling relapsing fever in man, and was essentially the same as the disease described in 1880 by Evans as "Surra," and only differed from it sufficiently to warrant his considering the cases as local varieties of the same disease.

Steel carefully watched and recorded the symptoms of the disease, confirming and adding to those previously described by Evans. He communicated the disease to the mule, pony, dog, and monkey, but was unsuccessful in his trials to inoculate bullocks and goats.

He found that the size of the parasite varies in different cases; usually one-sixth the diameter, and three to six times the length of a red blood corpuscle. In the fresh state it is an eel-like body; dried and stained, it looks like an oxyuris on a small scale, with a thick portion in its body, and a spiral tail. The body portion tapers in either direction, anteriorly it terminates rather abruptly, and is somewhat rigid, and there is apparently a holdfast organ at the blunt extremity. He describes the movements as being eel-like, lashing and vermiform, less frequently spiral, and believes the parasite to be a form of spirilloid, closely related to the spirillum found in relapsing fever in man.

He concludes by defining the disease thus: Relapsing fever of mules is an invariably fatal disorder, characterized by the periodical occurrence of attacks of high fever, during which a special organism closely resembling that of spirillum fever of man is found in the blood. The organism causes disorganization of the blood, which is to an extent repaired during the inter-paroxysmal phases, and thus the patient is usually able to hold up against the disorder for some time. But anæmic symptoms and lesions gradually accumulate, and culminate in death from exhaustion, plugging of vessels, or gastric perforation as a result of local atrophy of the stomach. In some cases the symptoms are acute, and the animal succumbs to the height of the fever.

Gunn, in 1886, reported on an outbreak at Kohat, on the North-Western Frontier, among the grass-cutters' ponies belonging to No. 1 Kohat Mountain Battery.

He noted the usual symptoms of surra in the four affected animals. On microscopical examination of the blood, he observed numerous minute parasites, somewhat like eels, which appeared to vigorously attack the red corpuscles; the parasite is not to his mind a spirilloid, nor does it resemble a nematode or round worm: the pseudopodia described by Evans are really the margin of the sides "waved." He estimates the total length at about ·0003, and the greatest breadth at ·00023, of an inch. He examined the urine of the four patients microscopically, and states that in three he found parasites, non-motile and probably dead. As to the mode of contagion, he thinks stagnant water was the source, for the following reasons:—

A.—Only grass-cutters' ponies were attacked by the disease.

B.—No mule belonging to the Mountain Battery, nor horse from the Punjab Cavalry, became ill of the disease.

C.—The grass which the grass-cutters' ponies bring in is alike eaten by mules, horses, and ponies.

D.—The mules and horses were watered at a stream, which runs from a mountain spring through the cantonment of Kohat, and at no other place.

E.—That the grass-cutters' ponies are watered at any place, pool, or otherwise, which happens to be at hand.

F.—The ponies stand in the same lines and partake of the same grain as the other animals, and the same system of sanitation appertains to all mules in the battery and regiment.

Experiments.—He inoculated a dog from a pony on the 20th September, and on the morning of September 24th many parasites were found in the blood.

The following is an abstract of a report by Veterinary Surgeon C. E. Nuttall, A. V. D., on two outbreaks of "Surra" at Meerut during the years 1886 and 1887, amongst the horses and baggage animals of the 19th Bengal Lancers. These observations were made under the personal supervision of Inspecting Veterinary Surgeon W. T. Russell, 2nd Circle, at the present time the Principal Veterinary Officer in India:—

The outbreak in 1886 commenced on the 3rd July, and terminated on the 22nd December of the same year. During this period, 48 animals succumbed to the disease, *viz.*, 25 horses and 23 grass-cutters' ponies, thirteen and six of each, respectively, having died, the remainder being destroyed. For those animals which died, the average number of days of the disease was for horses 36, and for ponies 6.

The outbreak of 1887 extended over 151 days, from September 6th, 1887, to February 4th, 1888, and attacked horses, ponies, and mules. Forty-seven in all died or were destroyed.

Veterinary Surgeon Steel happened to be in Meerut at the time of the epidemic, and at once recognised the disease as surra, organisms having been discovered at a later date in the blood of 15 out of 20 animals examined. It is of interest to notice that seven other animals were discovered suffering from fever, with yellow and petechial condition of the conjunctivæ, and a more or less degree of constitutional disturbance (symptoms frequently recognised by us in Poona, and by G. H. Evans in Burma), but these animals were not affected with surra, and recovered after a few days.

The outbreaks in Meerut, as in other localities, have occurred only at a special time of the year, *i.e.*, from the rainy season well into the cold weather, and up to the present time there are no sporadic cases on record as having occurred at this station at other times of the year.

The deaths during this period were in September, 10; October, 26; November, 7; December, 2; January, 2. The average number of days of disease in cases that died, being for horses 52, ponies 30, and mules 19. In this series of cases, the surra parasite was found in the blood at different periods of the disease in 43 out of the 47 attacked. Veterinary Surgeon Nuttall apparently experienced the same difficulty in determining the exact commencement of the attacks in animals as has been found by other investigators. All attempts at curative treatment were negative.

As regards the *post-mortem* appearances of the stomach, Mr. Nuttall states, that "it may be found in some instances replete with food, in others a little partly digested blood-stained material, fibrinous clots, etc., and the organ usually the seat of special lesions; which may be ulceration or erosion, either of the cuticular or villous portions, usually confined to the former, extending in some cases to perforation, the villous portion in places denuded of the epithelial lining, resulting from degenerative changes, and yellow pigmentation of varying intensity is constantly seen."

In the appendix to the report, it is stated that gastric lesions were found in the case of 25 horses, 15 ponies, and 2 mules.

Ranking published, in June 1891, a preliminary report, in which he states his opinion that surra is a disease of malarial origin comparable to ague, and that this view of its pathology is borne out both by the period of prevalence of the disease, which corresponds with that of ague, and also by the results of treatment. Quinine in full doses appears to control the disease, supplemented by general measures to combat the anæmia and weakness, consequent on prolonged illness, chiefly by milk, iron, and arsenic. He believes that the facts put now on record will, if allowed as guides to diagnosis, enable the disease to

be detected in the earliest stages, when it may be rapidly cured. The reason why "Surra" has hitherto been so uniformly fatal he believes to be simply because its real nature was not apprehended, and the disease allowed to run on till the vital powers were sapped by the constantly recurring fever. Giles investigated several cases which occurred at the latter end of an outbreak in Shillong, which from first to last resulted in the loss of between sixty and seventy animals.

The disease described by this observer was certainly not "Surra," but was due to the presence of the *Sclerostomum tetracanthum*. As early as 1865, Franck, and Fischer, working independently, published papers dealing with the anæmia, hæmorrhagic enteritis, and fatal colics produced by these nematodes.

Lieutenant J. Baldwin, R.A., has given the following information *re* surra in Burma:—

A section of No. 6 Bombay Mountain Battery left Bhamo in January 1891, and took part in the Wuntha expedition. (Wuntha is noted for the prevalence of surra.) No deaths occurred during the expedition, and the section returned to Bhamo at the beginning of April. In May, several of these animals which had had the hardest work during the expedition, *i.e.*, the baggage mules, suffered for two or three days from high fever. They apparently recovered, but fell off slightly in condition. In June they had another attack of greater severity. In July the same thing occurred, the animals becoming greatly debilitated During this month the attacks came on once a week, and this continued through August; all the symptoms clearly indicated surra.

In September four of the mules died, in October six, and in November five. This left only seven out of the original twenty-two baggage mules; of these seven mules, three had suffered from intermittent attacks of fever, and four appeared to be quite healthy. These seven mules started on another expedition in December 1891, and seemed at first to be picking up and doing well; however, in January 1892, two of them were again attacked with disease in so virulent a form that in the space of a week they were unable to stand, and had to be destroyed. The third mule had to be destroyed on the 1st April 1892; the remaining four mules were never sick, and are still working.

It will be seen from the above that "supposing the disease to have been contracted in Wuntha, which appears probable, as no other animals were attacked in Bhamo," the disease in one case lasted at least a year before a fatal termination.

On the expedition above referred to, which started in December 1891, the number of animals exceeded 400; there were among these only two other fatal cases—one from tetanus, the other from an accident.

The same officer also states that "from August 1890 to August 1891 the Chinese traders brought 6,500 mules to Bhamo from Yunnan. Fifteen hundred of these animals died of surra in Burma, and five thousand were left to make the return journey. On the return of the traders to Bhamo in the following year, and on their being questioned as to the condition of the animals which made the journey in the previous year to Yunnan, it was elicited that all of the animals, 5,000 in number, succumbed to disease, either whilst on the march, or on their arrival in Chinese territory."

The traders further stated that all mules brought by them from Yunnan on their last journey were entirely fresh animals, which had not been over the same ground in a previous expedition.

G. H. Evans, in reply to certain queries, informed Mr. Pease that "the popular idea regarding immunity of the indigenous ponies in Burma is a fallacy, as they die equally with other breeds, as also do the Panthé mules, which are bred in the Northern and Chinese Shan States; so much so is this the case, that hardly a mule or pony escapes in the Upper Irrawaddy, Mogaung, and Myitchna, so that all hope in the direction of naturally acquired immunity in indigenous breeds is lost.

"There is a form of bilious fever here exactly resembling many cases which we have had in the Poona Laboratory. Yellowness of the visible mucous membranes, and petechiæ on the conjunctivæ, with rapid loss of condition and occurrence of relapses; and this is no doubt very frequently confounded with surra. Evans has often been asked to destroy cases of this description, but, from the experience gained in an outbreak in 1890, he was led to discard all other symptoms as a proof of the existence of surra, and base his diagnosis solely on the presence of the hæmatozoon in the blood.

"In *post-mortem* examinations of surra subjects, ulcers, in various stages, are present in the majority of cases, shallow, deep, or small as the case may be. They present the appearance which may perhaps be conveyed best by the effect produced by a cockroach eating the surface of a patent leather boot.

"Spiroptera nests are by no means invariably found in the stomach; in fact they appear to be much rarer in Burma than in the Bombay Presidency."

The Panthés, who are great mule-breeders across our frontiers, state that surra kills a great number of their mules every season, in the valleys between the frontier and Yunnan. The same people also state that surra prevails in certain parts of the North and South Shan States.

In Burma the stations where the greatest mortality has occurred are as follows:—Mogaung, Bhamo, Mogok, Katha, and the Upper Chindwin.

In Lower Burma a few cases only have been observed,—*viz.*, in Rangoon, Prome, and Thayetmyo.

Mr. Remington, Managing Director of the Bombay Tramway Company, kindly supplied us in August 1892 with the attached statement, giving particulars of 14 horses belonging to the stud of the Bombay Tramway Company, which were attacked with surra fever in the months of November and December 1888.

Locality and description of the stable.—It will be observed that of the 14 cases of surra, 10 cases have come from the Company's Parel stables. These stables were constructed in 1886, with accommodation for 174 horses, and this was the actual number kept there during the two months when the outbreak prevailed. The stables are situated on the Parel Road, in the northern and most inland quarter of Bombay. They are bounded on the north by an enclosure about 5,000 square yards in area, which is used as a vegetable market, and skirted on (3) three sides by lines of brick-built chawls; on the south by an open space reserved for the purposes of a proposed new station by the Great Indian Peninsula Railway Company; on the east by the Parel Road, on the other side of which are the Victoria Gardens; and on the west by the Great Indian Peninsula Railway track, beyond which again for some distance there is open land. About 2,000 feet from the stables the flats commence: open, low-lying vacant land which extends for several miles, and the greater portion of which is under water during the monsoon. For the two and a half years the stables have been in use, there has, up to last November, hardly been a single case of fever in them. The stables are splendidly ventilated, and the drainage is on the surface system, and could not be better. The stalls and all the stable fittings are kept most scrupulously clean, and bad smells are unknown. The temperature at Parel generally ranges 2° lower than at Colaba, especially at night. The Colaba stables are situated in the Colaba Causeway. To the north is a large piece of *maidan*, belonging to Government, sometimes submerged during the monsoon for a few days at a time; to the south are goods stations and yards belonging to the two railway companies; to the east the Colaba Causeway Road, with the sea about 600 feet beyond; to the west open *maidan* with the sea distant about 1,000 feet. The average number of horses stabled at Colaba during November and December was 574. The drainage of the stables is inferior to that at Parel, being on an underground system. Great care, however, is taken in flushing the drains, and keeping the premises scrupulously clean. The ventilation of the stables is good. Fever has often been prevalent in these stables in October and November, but the number of fatal cases has been few, and the disease has usually disappeared as soon as the cold weather set in.

To sum up, the number of horses kept at Parel is less than one-third of that kept at Colaba; the interior sanitary arrangements at the former are superior to those at the latter; the record of fever cases at the former has up to November last compared most favourably with that at the latter; the temperature at the former averages 2° lower than at the latter. Notwithstanding all these facts to the credit of Parel, 10 horses have been attacked there during the recent outbreak of surra, against 4 horses attacked at Colaba stables.

Feed and water-supply.—(*a*) *Feed.* The Company's horses get from 12 lbs. to 15 lbs. grain per day, according to size. The majority of horses attacked with surra fever were horses receiving 15 lbs. grain feed. The feed in question was composed of a mixture of 8 parts, *viz.*, 3 parts gram, 3 parts barley, 1 part kulti (boiled), and 1 part Indian-corn. Their hay feed was 12 lbs. per diem. The hay is grown on black soil in Guzerat. Like all Indian hay, it is jungle hay, not raised on drained land. The grasses we prefer and chiefly for hay are Mosi, Daroia, Zinjva (known in the Deccan as "Sheerra"). From August to middle of October, in accordance with our custom for many years past, the horses received from 2 lbs. to 4 lbs. green grass daily, grown in the neighbourhood of Bombay. They also received daily 1 lb. bran and 1½ oz. salt. (*b*) *Water.* The water used in the stables and everywhere on our lines is all from the Municipal reservoirs at Vehar and Tulsi; Colaba stable is supplied with Tulsi water, and Parel stable with Vehar water. We had the water used at the latter stable, and the watering stations on the line near there, analysed by the Government Analyst, Dr. Lyon. The following is his report upon it:—

"Statement showing the results obtained on examination of four samples of water forwarded on December 18th, 1888, by the Superintendent, Parel Stables, Bombay Tramway Company:—

"Samples labelled—

No. 1. Parel Terminus.
No. 2. Parel Stable.
No. 3. Byculla Bridge, N. Side.
No. 4. Byculla Bridge, S. Side.

	1	2	3	4
GRAINS PER GALLON.				
Total solids	7·70	8·40	6·30	4·20
Chlorine	·91	·91	·84	·84
PARTS PER MILLION.				
Free ammonia	·04	·02	·02	·02
Albumenoid ammonia	·19	·18	·21	·17

"**Sediments.**—In all, scanty, chiefly vegetable débris.

"A few paramonia in No. 1.

"From these results, all four appear to be samples of water very similar in quality to the ordinary Vehar supply of Pombay. The albumenoid ammonia results are perhaps very slightly higher, indicating slightly more organic contamination. Were the case one of an outbreak of fever among human beings, I should say that it was very improbable that any connection existed between the outbreak and the water-supply."

Climatic conditions last year (1888).—The monsoon last year was an unusually light one, the aggregate rainfall being 59 inches, against an average of 75 inches. In September scarcely any rain fell, the total fall registered that month amounting to 3½ inches only. There was no rain in October, and the temperature, which throughout the month was unusually high, touched a maximum of 93° in the shade. Early in October, portions of the city were visited with a mosquito plague. The innumerable quantity of these insects in the air indicated something unusual in the climatic conditions, or in conditions of the marshes which skirt Bombay. The weather commenced to get cooler in November, and in the middle of December cold north-east and north-west winds set in, and have since continued, the former blowing during the night, and the latter during the day.

Breed of the horses attacked.—The Company had last October a stud of 739 horses; of these 570 were Australians, and 169 of Asiatic breeds. Of the 14 horses attacked with surra in November and December, 13 were Australians, and 1 was a Persian. The majority were young horses, well bred, and in excellent condition.

Preventive measures adopted.—As soon as we were satisfied that "Surra" had appeared amongst our horses, and that the causes producing it seemed in especial force at our Parel stables, we carried out a most careful and thorough examination of the watering and drainage arrangements at that stable. The results of the examination of the water have been given above. The stable drainage was found in good order, no stoppage anywhere; all drains clean and free from smell. A drain in the neighbouring property to the north was, we found, not working well, and we had it attended to. We disinfected the stables throughout on more than one occasion with phenyle and water, 1 part to 50, sending showers of it through the air in every direction from a manual fire-engine, and thoroughly drenching the roof and stable fittings. Carbolic powder was also sprinkled in all the stalls and sulphur and tar burnt in braziers in the passage-ways. We noticed that the majority of the horses attacked had been standing in portions of the stable most exposed to the north-west and north-west winds, and

that it was since those winds had turned cold in the evening and at night that the outbreak of "Surra" had occurred. With a view to obtaining thorough ventilation in the hot weather, our stables at Parel are very open in their construction, and although the venetians, with which the sides are fitted, are closed at night, it occurred to us that at certain places the horses were more exposed than they should be to the night winds. To provide against this, we effectually protected the horses from all apertures whence these winds could enter and blow upon them, and considerably increased the warmth of the stables at night, by the erection of bamboo and matting screens across the principal entrances. We also gave all the horses standing at Parel a light course of antiseptic medicine. For three days each horse had daily two drachms hyposulphite of soda, and one drachm nitrate of potash, mixed with his evening grain feed. These preventive measures were carried out the latter part of December. It was during the last week of that month that we set up the screens, etc., which effectually protected the horses at Parel from cold winds. Simultaneously we introduced stringent regulations at Colaba for the complete protection of the horses there, and maintenance of a more even temperature in the stables at night. Since the 1st January we have so far had no fresh case of surra.

Possible causes of the outbreak.—The professional opinion as to the source of "Surra" expressed by the Government Veterinary Officers, Mr. Burke, Mr. Evans, and Mr. Steel, in their treatises on this disease, is, that the parasites which give rise to it enter the horse's system either with his food or his water. In the Company's stables, the water-supply, pronounced a pure and wholesome one by the Government Analyst, is the same as has been in use for several years past, and no alteration has been introduced into the character of the grain and hay feed. The drainage of the Parel stable, where two-thirds of the "Surra" cases occurred, is exceptionally good, much better than the drainage at Colaba stables. Immediately to the rear of the stables at Parel, there is a depôt for manure. The dung both from Colaba and Parel is transported there. Thence it is daily removed by carts. A portion of it remains there throughout the night, but none of it remains there longer than the morning subsequent to the day of its receipt. At our old stables at Byculla a similar depôt existed, but the manure remained there for three days before removal. At neither stables has the existence of this depôt heretofore been a cause of unhealthiness. The fever record of the Parel stables for the two years of their existence prior to last autumn has been an extremely satisfactory one, very much more favourable than the record at Colaba. We cannot, therefore, find anything in the feeding of the horses, their watering, or the drainage of their stables which would account for the outbreak. All these conditions, in so far as they

affect the horse's health, have been, to the best of our belief, precisely the same these last four months, as during the many past years when "Surra" was unknown to us. We, therefore, seem directed to seek in some special climatic and atmospheric conditions for the explanation of the outbreak. October and November last were notoriously exceptionally unhealthy months in Bombay. Malarial and typhoid fevers were prevalent, and many cases ended fatally. Unusually unhealthy months for human beings, they would appear to have been unusually unhealthy for horses also. The outbreak of "Surra" fever was not confined to the Company's stables. Several horses attacked with it were sent to the Government Veterinary Hospital, and others to the private veterinary establishment in the city. Probably, a far larger number died in their owners' stables. Amongst the cases observed, we have not heard of a single recovery. Taking all the above facts into consideration, the opinion we have been led to form is, that there was some specially unhealthy influence in the atmospheric conditions this last autumn, which predisposed horses to this particular blood-poisoning fever, and that the specific cause which developed the disease into activity, in the horses attacked with it, was getting chilled from exposure to the cold northerly winds, which during the latter half of November and the month of December blew in the evening and at night. This is the conclusion to which we have been led as the result of our own experience of the disease. In support of this opinion we have the following facts:—(1) That the horses attacked were found to have been especially exposed to cold night winds by their position in the stables or nature of their work. At Parel stables, where the majority of cases occurred, alterations in the buildings were in progress. The south wall of the stable had been taken down in order to increase the number of stalls in that direction. This open condition of the premises on that side, while it did not expose the horses to any unwholesome wind (the south wind only blowing in the monsoon time, and being a warm one), tended, no doubt, to increase the draught through the stables from the north, and to lower their temperature at night. (2) That since the time when we introduced measures for protecting the stables from the northerly winds (a period of five weeks), no fresh case of "Surra" has occurred. The last case at Parel stables appeared on the 29th December. It was on the 30th of that month that we completed the arrangements for excluding cold winds. (3) That the Parel stables, where nearly three-fourths of the cases occurred, were, until recently, in consequence of their system of construction, more open and considerably colder than the stables at Colaba. (4) That there is nothing ascertainable in the feeding or watering of the horses, differing from the feeding or watering during previous years

when surra was unknown to us, or which can, in our opinion, in any way account for the outbreak.

In connection with the exposure of the horses to cold winds, and our opinion that the chill to the system therefrom resulting was the immediate factor producing activity in the disease, we may mention that out of 8 horses working as "helping" horses on the Byculla Bridge, no less than 3 were attacked with 'Surra,' and of these, 2 were attacked upon the same day. Compared with the work most of our horses do, the work of these particular horses was light, and they were in specially good condition and of exceptionally fine physique. These horses are attached as additional horses to help in pulling cars up the inclines on the bridge. After pulling up a car, they return to the little waiting sheds provided for them at either end of the bridge, and stand usually about five minutes, until another car approaches.

On examining these sheds, we found them a good deal exposed to the north wind. We have now protected them, but it is easy to understand how in the early morning, or between 7 P.M. and 11 P.M. at night, these horses, after getting warm at their work, would be specially liable to chill when standing waiting in sheds, until recently not very well protected from cold winds.

In the plains of America it has been noticed that in certain thinly-populated districts, where fever was prevalent, the introduction of railway tracks and the passage of trains has modified the sanitary conditions. The theory in explanation of this fact is that the displacement of air caused by the rapid passage of the train creates a vacuum and consequent draught, and that a rush of fresh air is, in this way, introduced. In other words, the train produces a sort of artificial wind. The track of the Great Indian Peninsula Railway passes immediately behind our Parel premises, distant only 75 feet from the stables. About 2,000 feet further to the north, the flats commence and are crossed by the trains. In this memorandum we are anxious to enumerate all possible influences which may have served in the production of the recent outbreak of surra. It is perhaps worthy of consideration whether the Great Indian Peninsula Railway track, which very shortly after leaving the marshy land of the flats passes our Parel stables on their north-western side, does not act as an air-channel from the one to the other. The line of horses standing next to the railway was the line in which the "Surra" was by far the most prevalent.

A conjecture has been put forward by some veterinary authorities in India that there is a connection between "Surra" and rats. A parasite has been found in the intestines of rats, which is similar to the parasite noticed in the blood of horses suffering from surra. It is suggested that where rats have access to grain, it becomes contaminated with their

excreta, and that when used for horses' feed, the parasite may in that way be conveyed into the horses' stomachs. In view of this theory we think it right to mention that although the greater portion of our grain is kept in paved godowns, and we do our best to exclude rats, yet we know that both before and after the grain is received by us, rats do frequently get at it. But before our grain is used for horses' feed, it is carefully cleaned, both by hand and through a machine. We ourselves cannot, from our own observation, favour the rat-infection theory. If the source of the disease is due to grain getting mixed with the excreta of rats, why is the appearance of fever limited to certain seasons, and whys hould it appear only in certain years? For the past fourteen years it has been unknown in our stables, and during those years our stocks of grain and hay have been less well protected from the incursions of rats than they have been during the past twelve months.

We have now, we think, exhausted all we are in a position to state with regard to our own experience of "Surra" fever. We submit these few remarks on a veterinary subject as proceeding of course from a non-professional pen, and while we trust to be pardoned any mistakes into which we may in consequence have fallen, we hope that our experience may be of value to those who are making this disease a subject of special study. As a large owner of horses, this Company is deeply interested in researches which have for their object the discovery of a remedy for this most fatal form of equine fever.

GEOGRAPHICAL RANGE.

The geographical range of this disease is much wider than it was once imagined, and is one of the most important diseases affecting equines met with in India. According to Evans, the natives of Dera Ismail Khan on the North-Western Frontier, east of the Indus, have known this disease for several generations as an occasional scourge. It has now been recognised all along the low country bordering the Indus. In the seventies at Asin, near Rajanpore, one cavalry regiment (3rd Punjab Cavalry) lost 350 horses. In the late war it caused enormous mortality among horses, mules, and ponies, used in Upper Burma, and according to Steel ninety-eight per cent. died from it and *Komree*. Surra is endemic in the Island of Bombay, and has been frequently recognised in animals in the low districts lying below the Western Ghâts, called the Konkan, and less frequently in other parts of this vast continent, separated from each other by many hundreds of miles,—*viz.*, in the Berars, in Meerut, and other parts of the North-Western Provinces, as well as in Assam and Cachar. Blanchard recognised this disease in Tonquin among the transport mules belonging to the French Government. In 1876 a disease was pointed

out to Haig in Persia, which he was told was invariably fatal, the cause of which the natives ascribed to the animals drinking impure water. On Haig's return to India he became acquainted with surra, and then recognised that the Persian animals were affected with all the outward ymptoms of that disease. There are reasons for believing that animals have succumbed to this disease in Abyssinia, and probably also in Southern Europe, Nroth America, Brazil, East Africa, and Australia.

Further information is wanted under this head.

Symptoms of naturally-contracted Surra.—*Horse.* The invasion of this disease is usually marked by symptoms of a trivial character, those of a slight attack of fever being the only ones noted. It may occasionally happen that the fever may be accompanied or even preceded by local or general urticarial eruption. If the blood be examined microscopically during the period of fever, it will present a normal appearance as regards the disposition of the corpuscles, etc., but certain rapidly-moving organisms will be found, which induce in the corpuscles a peculiar vibrating movement, which if once observed will not be readily forgotten.

If no microscopical examination is made, and the patient is treated with febrifuges, it apparently regains its health. After an interval of a few days during which the infusorian in its mature form is not present in the blood, the animal again becomes ill, and on examination well-marked symptoms are found; the skin is hot, the temperature more or less elevated; the pulse is full and frequent, 54 to 64 beats per minute; the conjunctival membranes, especially those covering the membrana nictitans, are usually the seat of dark-red patches of ecchymosis, varying in size. The thirst may be slightly increased and the appetite somewhat disturbed. At the same time slight catarrhal symptoms, including lachrymation and a slight mucous discharge from the nostrils, may be present. The submaxillary glands may, at this period, be slightly enlarged and tender on pressure. At this stage some swelling and œdema of the extremities, generally from the fetlocks to the hocks, which pits, but is not painful on pressure, makes its appearance. This swelling gradually increases in size, and invades at a later stage the sheath and under-surfaces of the abdomen and chest.

If the blood be examined microscopically during the second paroxysm of fever, the infusorian will be discovered. Following this second paroxysm we have a period of apyrexia during which the infusorian in its mature form is absent from the blood, also the intensity of the symptoms is abated and the animal has a brighter appearance; the temperature falls occasionally to normal. During the period of apyrexia the ecchymoses gradually fade out; the pulse becomes weaker and thready, but the appetite is excellent. In some cases the amelioration is

so marked, during the early remissions, that were it not for the presence of the œdema and the falling off in condition, there would be little to show that the animal is ailing. A third relapse or paroxysm, however, soon occurs, and all the symptoms are increased in intensity. The action of the heart becomes irritable, the pulse full and quick, and at times we note jugular regurgitation, the respirations are shallow. The swelling and œdema increase very considerably. These paroxysms and remissions continue, and the condition of the animal becomes steadily worse. Towards the termination of the disease, it will be noticed that an animal is disinclined to move, and when made to do so, it will be seen that there is loss of command over the hind quarters simulating slight paralysis, so that the gait is unsteady. We frequently notice paralysis of the sphincter ani. These symptoms, taken together, point to some interference with the normal functions of the spinal cord in the lower dorsal and lumbar regions, and are probably caused by pressure due to effusion within the spinal membranes.

In many cases shortly before death, the heart's action becomes very violent (anæmic palpitation) shaking the whole frame at each beat, so that the sound can be heard at some distance from the animal. In some cases the animal suddenly drops dead, whilst in others the emaciation and weakness become so pronounced, that the animal falls to the ground and is unable to rise, and after a short bout of struggling, death occurs. In other cases, again, the animal falls to the ground and appears to suffer the most acute pain, struggles violently, sweats bedew the body, and the respirations are very hurried. The struggles soon exhaust the strength, and for a short time the animal lies quietly; soon, however, the struggles commence again and continue until death occurs. The principal symptoms then may be summed up as follows:—Paroxysms and remissions of fever and the presence or absence of the infusorian. Progressive emaciation and weakness, ecchymoses of the visible mucous membranes, the occurrence of extensive œdema on the limbs, sheath, under-surface of the abdomen and chest, progressive and pernicious anæmia, and death either from exhaustion or from complications.

Symptoms of Inoculated Horse Surra.—The symptoms of surra produced by inoculation differ in no marked degree from those of the naturally-contracted disease. The only ones to be noted are those which occur at the seat of inoculation. Twenty-four hours after the inoculation (subcutaneous injection) of a small quantity of surra blood, in the great majority of cases, a small, circumscribed, and somewhat raised swelling is noticed at the seat of inoculation; after forty-eight hours the tumour has increased in size, and is accompanied by some œdema; it presents a certain amount of tension of the parts involved, and is generally

tender on manipulation. These conditions continue to increase until the fourth day; the tumour may measure three or four inches in one direction by two or three in the other, and be raised to the extent of an inch or more above the surrounding tissues, from which it can be lifted. According to the amount and the nature of the inoculated blood, so will these symptoms rapidly develop themselves, until, after a period of from four to thirteen days in the majority of cases, the tumour will be found to have become less tense and tender; and when this is noticed a microscopical examination of the subject's blood reveals the presence of the infusorian. After this the tumour gradually disappears, and the symptoms of surra are present, and run through their ordinary course.

Symptoms of Inoculated Surra in Bovines.—To Dr. Lingard is due the credit of having demonstrated the possibility of producing surra in bovines, by the subcutaneous inoculation of blood containing the infusoria, taken from the horse.

The symptoms noted at the seat of inoculation in the horse occur also in bovines, and a few days after inoculation the infusorian appears in the blood, and we have the symptoms of a mild paroxysm of surra. Two or even more paroxysms may occur, but they are usually of a mild character. After these mild paroxysms, in the majority of cases the animal seems to be in perfect health, and no infusoria are, as a rule, detected in the blood by microscopical examination, so that we should, if we trusted to this method of examination alone, be led to the belief that they had completely disappeared. Such, however, is not the case. We inoculated guinea-pigs with the blood of a bull in which surra had been produced, but in the blood of which no infusoria had been detected for a considerable time,—83 and 165 days,—but strange to say the inoculation was followed by virulent surra and the guinea-pigs died.

Blood taken from the same animal produced no results when inoculated into guinea-pigs, after 234 days, 267 days, and 356 days.

One bull was in perfect health 512 days after inoculation, and we decided to subject him to re-inoculation with virulent material. The result was negative, and he seemed to be protected. The course of the disease in bovines may be summed up as follows:—One or two mild paroxysms during which the infusoria are few; intermissions; considerable loss of condition; recovery of health and condition.

Symptoms in the Sheep and Goat inoculated with Horse Surra.— The disease behaves in a peculiar manner in the sheep. There is little disturbance attributable to the action of the infusorian, which appears to be unable to develop in the blood. The infusorian sometimes develops in the fluid in the *tunica vaginalis testis*. Although the

mature form was absent from the blood, it is interesting to note that when blood was taken from a sheep 18 days after inoculation with Horse Surra, and guineapigs were inoculated with the same, it caused Surra.

Guinea-pigs.—These animals present typical symptoms of the disease; paroxysms and intermissions, gradual progressive anæmia, and death.

Dogs and Cats.—The disease follows the same typical course; œdematous swellings appear on the head, face, and limbs. There is progressive anæmia from which death results.

Analysis of Symptoms in the Horse.—*Skin.* An urticarial eruption is occasionally noticed on the skin, about the time, or shortly after, the infusorian enters the circulation.

Temperature.—It has not been possible to secure records of the temperature of animals during the incubative stage of the spontaneous disease. In inoculated cases the temperature curve has been variable, but ordinarily in healthy horses it remains normal, or slightly rises after inoculation. After the appearance of the infusorian in the blood, the temperature varies very considerably, giving to the fever different types in different animals. Hence in some cases we meet with a relapsing type, in others a remittent; at first the rising and falling of the temperature is concomitant with the presence or absence of the infusorian, but when the disease has been running on for some time there comes a period, *some days* before death, when the temperature remains elevated until *immediately* before death, when it may become subnormal.

Pulse.—The pulse is, at the commencement of the disease, full and strong during the paroxysm of fever, but seems normal during the fever-free period: soon, however, as the anæmia progresses, we find that the pulse becomes gradually weak and thready, and in many cases dicrotic. It is naturally quick during the paroxysms of fever, and generally regains about the normal number of beats during the apyrexial periods. As Steel remarks, the tracing from the number of pulse-beats resembles that from thermometer readings. Towards the end of the disease we find the pulse much disturbed, increased in frequency and altered in character.

Respiration—The respirations do not, as a rule, offer any marked changes, following the course indicative of fever only.

Digestive apparatus.—The appetite is usually persistent throughout, excepting at times when the fever is very high. This is a marked peculiarity of surra, as in no case of other forms of fever do we find

an animal exhibiting the appetite which we see throughout the course of this disease. The tongue and mucous membrane of the mouth become first pale and later yellow in colour. Small ulcers are often noted on the sides of the free portion. The bowels are, as a rule, constipated, and we have symptoms of hepatic disturbance in the colour of fæces, and the fact of their being coated with mucus. Diarrhœa may come on towards the end of the disease, but is not invariable.

Jaundice is a very constant symptom in every case at one period or another. It sometimes appears early, and may be evanescent in character, appearing with each paroxysm, and gradually fading during the intermission. In the majority of cases, however, the yellow colour of the membranes is intense and persistent.

Urinary System.—The urine changes in colour after the disease has somewhat progressed, becoming viscid and green in many cases. The reaction is usually alkaline until five or six days before the termination of the attack, when it becomes acid. Albuminuria appears after the disease has run a part of its course, the quantity of albumen passed being very considerable as the disease progresses. Microscopical examination of the urine generally reveals the presence of epithelial, blood, and granular casts—signs of desquamative nephritis. The symptoms of kidney disease, other than those found on microscopical examination, are usually not well marked.

Organs of Vision.—Opacity of the cornea may be present, but it is not common. Extravasations of blood into the anterior chamber are occasionally met with. There is usually some lachrymation.

Organs of Smell.—Ulceration inside the nostrils has been noted by Steel in some cases. There may be slight epistaxis; petechiæ are constantly present on the Schneiderian membrane, which latter is often tumefied. During the second week after invasion, there is a slight discharge of clear fluid from one or both nostrils.

Course of the disease.—In the horse, the course of the disease is very variable. The period of invasion has not been carefully observed in naturally-acquired cases. We divide the disease into paroxysms and intermissions. The periods of intermission are short, being of two or three days' duration or less. The paroxysms last from two to twenty-one days. Death occurs sometimes after the first paroxysm, but it may be de'ayed until the seventh or even later.

Diagnosis.—The demonstration of the infusorian should always be made. It must be remembered that it is not present in the blood continuously, being absent during the intermissions; so that it is necessary

to make daily observations for a few days, if the first examination is not satisfactory. The history of the case, the condition of the animal, the presence of the œdema, and state of the membranes, lead us to suspect the nature of the disease.

Prognosis.—Invariably fatal, no equine ever having been known to recover.

Post-mortem appearances.—There are no specific lesions characteristic of the disease. A general anæmic condition of all organs will be noted. Some observers have noticed peculiar ulcers in the stomach in Burma, but we have never met with them, nor have other observers (Gunn, Evans). The heart generally presents some abnormal appearance, the most common being very extensive sub-endocardial ecchymoses. The kidneys often appear congested and ecchymosed, but not always.

Etiology.—Everything points to the infusorian (*Trypanosoma Evansi*) as the *vera causa* of surra, although absolute proof is still wanting, owing to the fact that it has not been obtained free from the blood, etc. (pure), although numerous attempts have been made, so that we have been unable to use pure cultivations of it for inoculation, and the production of the disease. The following facts go to show the intimate connection which exists between the organism and the disease:—

1. No case of "Surra" naturally contracted has been observed in which the *Trypanosoma Evansi* has been absent, and all previous authenticated cases investigated by such observers as Evans, Steel, Pottinger, Gunn, and Rimington tend to confirm this.

2. In all cases of the inoculated disease, the organism has been present, and has comported itself in a similar manner to that which has been observed in naturally-acquired cases.

3. By passing the infusorian through the organism of various animals, and after it has been passed through a large number, again bringing it back to the horse, fatal surra, with all its distinctive characters, has again been induced, and the infusorian has always been present.

4. The serum of blood swarming with the infusorian, when passed through a porcelain filter, and thus deprived of the infusorian, fails to produce surra on inoculation, and the infusorian is never found in the blood of the inoculated animal in these circumstances.

5. In addition to this, we have the undoubted influence which the presence or absence of the infusorian has upon the course

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of the disease, dividing it, as it does, into its various stages, *viz.*, paroxysms and intermissions. It may be generally accepted that the appearance of the infusorian in the blood is quickly followed by a rise in the temperature, and, as a rule, its disappearance is soon followed by a corresponding fall. During the presence of the organism in the blood all the phenomena of a paroxysm of "Surra" appear, while after its disappearance there is a very marked diminution in the severity of the symptoms. And so much is this the case, that in some instances at the commencement of an attack, an animal has been sent to work after the first paroxysm, being apparently well.

That the infusorian is the *vera causa* of surra is also rendered more probable by the fact that the disease is chiefly endemic in localities which are, at certain periods of the year, favourable to the development of low forms of animal life. This is believed to be due either to these places being subject to inundations, or to their being low-lying and swampy. In those cases where the infusorian gains access to the system by means of the digestive organs, we must take into consideration the influence which wounds and other lesions have in favouring its entrance. In this regard, we find that out of 19 horses spontaneously attacked with the disease, no less than 12 were the subjects of attacks of *Spiroptera megastoma* or other parasites, which cause lesions of the gut. The localities where surra is enzoötic belong to two distinct kinds of climates. The one with a heavy rainfall, high temperature, and humid, steamy, atmosphere; the other, a dry arid neighbourhood, presenting a great annual range of temperature. But in both these classes of localities, inundation of land during the rains leaves the fields covered with mud, and evaporation and concentration of the water in the tanks occurs during the hot season.

Mode by which the infusorian gains access to the system in naturally-acquired cases.—Most observers are agreed in blaming the water as a medium by which the infusorian gains access to the system, but no definite proof that this is the case has yet been adduced. Sedgy vegetation, from inundated or swampy ground, is also suspected to be a vehicle by means of which the infusorian may gain access. Granted that the infusorian is the *vera causa* of the disease, it may be logically deduced that we are justified in condemning the water remaining after inundations, or that from low-lying stagnant pools and wells, and also sedgy vegetation from places of a similar physical character, as we are well aware that such agents are favourable for the development of low forms of life, infusoria, etc. But the mature form has not yet been demonstrated either in stagnant water or

on sedgy vegetation, so that we are unable to state with certainty that these media really do convey the *materies morbi*. It is possible that the infusorian does not exist in its mature form in either of these media, but that there may exist an immature form which has not yet been recognised. The excreta of rats has been blamed by some as a possible medium, and no doubt on good grounds, for we know that an infusorian apparently identical with that found in Horse Surra is very frequently found in the blood of these animals, and that this being the case, should any of the blood be passed with the fæces or urine, it would be quite possible that surra might be induced in horses which consumed them with their forage. Be this as it may, in Poona it has been found impracticable to induce "Surra" by feeding horses with a considerable amount of dung obtained from rats, in whose blood the infusorian is present in large numbers (swarming). The infusorian can be absorbed into the circulation from the digestive system, as has been proved by giving small quantities of blood containing it in the drinking water.

Contagion.—From the evidence we have at hand it would appear that surra is not communicable by the sick to healthy animals, except under certain conditions. The disease is not contagious in the ordinary acceptation of the term. The contagium is neither conveyed by the air, nor by the sick to the healthy, but gains an entrance with the food and water, or is introduced by some form of superficial inoculation; and it is necessary for one or other of these two forms of inoculation to take place, in order that the disease be successfully transmitted.

The blood of an affected animal when introduced subcutaneously into a healthy one, possesses the power of reproducing the same disease *whether the infusorian at the time of its withdrawal be capable of demonstration by microscopical means or not.* As regards the quantity required, it has been found that the fraction of a minim of soiled blood, containing the infusorian, placed between the edge of a minute wound in the cuticle of a healthy horse, was sufficient to reproduce the disease in seven days.

Possibility of Contagion.—Taking into consideration the above fact, it is easy to understand that there is some danger of the disease being transmitted by the bites of certain flies, especially by blood suckers armed with borers, for it is quite possible that a certain number of the infusoria may be carried on the proboscis and inoculated into healthy horses, specially when they are kept close together.

With the knowledge of the fact that a small quantity of blood in water may, when swallowed, induce the disease, we may consider it possible that the discharge from a sick animal, if containing blood, may

soil buckets and forage, which may be used by healthy animals and serve to transmit the disease to them.

Although the possibility of these methods of mediate contagion cannot be denied, it appears to be evident that they are not of common occurrence.

Are the excreta of animals suffering from surra capable of transmitting the disease? This is a most important question, and one which we are so far inclined to answer in the negative. Gunn was of opinion that the infusorian was passed out of the system by the urine, and stated that he had seen it undergoing changes in that fluid. That this is possible in some cases we are not in a position to deny, when we take into consideration the fact that in those cases where nephritis occurs, we have a considerable quantity of blood passed in the form of "casts" from the kidney. In order to ascertain whether urine constituted a danger in the transmission of the disease, we undertook a series of experiments.

The urine of animals, in whose blood the infusorian was numerous, and in cases where the disease had reached an advanced stage, was given by subcutaneous inoculation to guinea-pigs, but in every case the results were negative. It seems, therefore, that we cannot seriously consider the urine as a cause of danger.

With regard to the fæces, we have had animals suffering from surra tied on either side of a healthy one for months, under such conditions that every opportunity was given for the soiling of hay with their excreta, but there has been no communication of the disease by this means; although the animal has been eventually inoculated, and has died from surra.

Is the prevalence of surra in direct proportion to the degree of intercourse between the sick and healthy animals? We have abundant evidence to prove the contrary. Evans states that "seventy-seven horses of the 3rd Punjab Cavalry becoming affected with surra at Jutta, from which they all died at Edwardesabad, did not communicate the disease to other animals." Gunn found at Kohat that "the grass-cutters' ponies stood in the same lines as the other animals, but no mule belonging to the Mountain Battery nor horse belonging to the Punjab Cavalry became ill of the disease."

Again, in the Bombay tramway outbreaks, with one exception, the animals attacked with surra were not found to be in close proximity to each other, but were dotted about over the large area which the stables cover, and surrounded by healthy animals which remained free from the disease.

Again, we have the fact that on several occasions it has happened that Australian horses belonging to the Tramway Company, which had been under one year in this country, have been the first animals attacked

during the year with surra, so that contagion from horse to horse is out of the question in these cases.

Beyond this, we have the fact that there is no record to be found of surra having been imported or become enzoötic in a locality, as the result of the introduction of animals suffering from the disease.

With this evidence before us, can we consider the disease to be contagious, or are we to look upon animals suffering from the disease as a source of danger to healthy animals? The answer appears to be in the negative, and we are led to the opinion that surra is what might be called an "accidental" disease of the horse, introduced from without, owing to the animal ingesting the infusorian; and not contagious in the ordinary acceptation of the term, but only under certain conditions.

The disease can be transmitted from a sick to a healthy animal, (i) by subcutaneous inoculation with blood, whether it be taken during a paroxysm or intermission serum, fluid taken from the tunica vaginalis, the pericardial sac, and lateral ventricles. (ii) By the gastric ingestion of such blood. (iii) By direct injection into the general circulation.

Blood taken some hours *post-mortem*, and from which the infusorian has apparently disappeared, will also induce surra on inoculation.

Experiments are necessary to show for what length of time the blood remains virulent after death.

Period of Incubation.—It is impossible to say precisely what the period of incubation in naturally-contracted cases of surra may be, but it is probably between 39 and 67 days.

In cases induced by the subcutaneous inoculation of blood taken during a paroxysm, we find it to be usually from four to seven days, and it is about the same when the infusorian is injected directly into the general circulation.

If the blood be taken from the heart or great vessels some hours after death (5 to 16 hours), we find the period of incubation lasting from 8 to 13 days. We find that there is some increase in the length of the period here; and it appears that some change occurs after death which delays the process; for, with blood taken only an hour and a half after death, the incubative period was only 6 days. Cases due to gastric ingestion of large quantities of blood containing the infusorian have an incubative period of 5 or 6 days, but if the quantity of blood be small it is very long and variable.

Animals susceptible to Surra.—Horse Surra may be transmitted by inoculation to the donkey, mule, ox, sheep, goat, monkey, dog, cat, rabbit, guinea-pig, and rat.

In the donkey and mule, it runs a course similar to that in horses, but it is usually slower, taking much longer to kill them. In the dog,

cat, rabbit, and guinea-pig, it resembles surra affecting the horse. Dogs and cats have œdematous swellings on various parts of the body, especially on the legs and head, and they gradually waste away and die.

Sheep and goats appear to be less susceptible, but when attacked invariably die.

The ox takes the disease, which runs a very prolonged course, but does not cause death.

Months of the year during which Surra is prevalent.—The months during which the outbreak of surra is most to be feared are September, October, November, and December,—*i.e.*, towards the end of and in the two months following the rainy season.

Treatment.—The treatment of this disease has not, so far, been attended with success. Experiments have been made with various medicinal agents, chiefly those which it was considered would destroy the infusorian in the blood.

It has been considered that the best mode of proceeding in the use of these medicines is to introduce them in small but gradually increasing doses, pushing them to such a degree as to produce their full physiological effects, but stopping short of actual poisoning. This appears to be the most rational method of adopting experimental treatment, if our object is to be the destruction of the infusorian. A mixture of *carbolic acid and iodine* was given in one case, in such a manner that seventy-six drachms of the former and thirty-four drachms of the latter were given in a period of six days. The patient received on one day, during the treatment, fifteen drachms of carbolic acid and eight drachms of iodine; but no apparent effect was produced on the infusorian. *Cinchona alkaloids with arsenic* was next tried, and in one case 1,620 grains of cinchona alkaloids and 44 grains of arsenic were given in five days; in another case, 7,920 grains of cinchona alkaloids and 355 grains of arsenic were given in a period of 32 days. In a third case, 7,680 grains of cinchona alkaloids and 427 grains of arsenic were given in a period of 29 days. We found in these cases that some effect was produced on the infusorian, inasmuch as the mature or recognisable form was absent for a very considerable time from the blood; but we found also that it is impossible to continue with large doses of the mixed cinchona alkaloids, owing to the irritation which they set up in the digestive organs. The number of days during which the infusorian was absent from the blood of horses treated with this mixture was 27, 26, 12, and 10, respectively. Seeing that in the ordinary course of the disease the infusorian reappears after an absence of from three to six days, we are justified in considering that one or other or both of these agents has some good effect in checking the development of the disease, especially as the

animals treated with them lived longer than ordinary. To one horse we gave 10,380 grains of the alkaloids and 373 grains of arsenic in 34 days; and in this case the toxic effects of the alkaloids were very pronounced, but we failed to destroy the infusorian. We now deemed it advisable to drop the cinchona alkaloids, and to pursue the treatment with arsenic alone. The amount of arsenic which was given in one case was 795 grains in 87 days. The infusorian was absent from the blood for 84 days, and the animal lived for 110 days: here the effect of the drug was well marked; the infusorian appears to have been destroyed, but before this happy result was arrived at, the disease had so far advanced that recovery was not possible. Other cases treated with arsenic were not so successful; indeed, the above was the most encouraging case we had. Other agents have been tried: Hydrarg perchlor, both by subcutaneous injection (2·60 grammes in six days) and by direct injection into the jugular (9·25 grains in one day), but the results were negative: iodine and iodide of potassium were also given. Iodoform in ether injected subcutaneously (7 grains in two days); injected into the jugular vein, 44 grains, three days. Potassium bichromate injected into the jugular vein, 23·5 grains in four days, and by gastric ingestion 2,378 in 16 days. Quinine and arsenic by gastric ingestion, 1,980 grains of the former and 72 of the latter in six days. With regard to quinine, Ranking had stated that large doses would bring about recovery. In order to test the veracity of this statement, we gave in one case six drachms of quinine on one day, six on the next, and six on the following day; this produced no effect whatever. Oleum terebinthinæ was also tried. None of the medicinal agents above mentioned have given us any encouraging results with the exception of arsenic.

Iodic Hydrarg has also been administered, but with negative results.

Protective Inoculation.—A series of experiments were conducted to test the efficacy or otherwise of the blood serum as a protective agent against the inoculated disease, or, in other words, to ascertain whether any substance capable of conferring immunity against the disease was present in it, when obtained from animals in whose circulation the infusorian of surra had been swarming for some days previously. In the first series, fresh blood containing numerous infusoria was drawn from a horse, immediately after death, into sterilised glass vessels, and set aside for several hours in order to allow of the serum separating. The serum was then transferred to one of M. Pasteur's filters and forced through a porcelain cylinder. Three rabbits and two guinea-pigs were then subcutaneously injected with varying quantities during three days. On the evening of the third day, each animal received subcutaneously 0·2C.C. of blood containing numerous infusoria. Rabbit A, which had received 3·0C.C. of serum, died in 24 days from surra.

B received 6·0C.C., died in 22 days. C received 9·0C.C., survived 40 days. Guinea-pigs: X received 6 00C.C., lived 34 days. Y received 6·00C.C., lived 66 days.

In the second series of experiments, blood was withdrawn from a horse immediately after death, in which the infusorian had been swarming for some days, and immediately subjected to the method described by Ogata. Three guinea-pigs were subjected to daily injection with the fluid so obtained, in varying quantities.

No. 1 received 5·5C.C., and afterwards was inoculated with virulent blood. The animal succumbed in 66 days. No. 2 received 8 5C.C., and died in 19 days. No. 3 received 11·0C.C., and died in 25 days.

It is evident that there is little to be hoped for in this direction.

Measures to be adopted to prevent introduction and spread.—In recommending measures to be adopted with a view to avoiding the introduction of the disease, we are met with the difficulty of deciding what the source is from which the infusorian is introduced. We have some evidence to show that stagnant water, and sedgy vegetation from ground liable to inundation, are to be suspected, and we should prevent animals from gaining access to these for some time previous to the dangerous season of the year. Looking to our observations as to the period of incubation, in cases where the disease has been induced by the ingestion of water containing small quantities of soiled blood, it would appear to be necessary to allow for an incubative period of at least two months, which would bring us to the commencement of the rains. In this regard may be quoted the fact stated by Major Money, 4th Punjab Cavalry. This officer has stated that "the disease was common amongst the horses of the 3rd Punjab Cavalry, when they obtained the grass from inundated ground near the River Indus, but it ceased when they got grass from higher ground."

Veterinary Lieutenant-Colonel W. A. Russell informs me that he was successful in preventing the disease by avoiding grass from suspected localities in Meerut, and that since this has been done, no cases have occurred there.

Salt.—It would be advisable, in addition to interdicting the use of grass and water from suspected localities, to allow each horse an ounce of salt well mixed with the food and water daily as a prophylactic.

Arsenic.—It has been suggested that by giving arsenic as a prophylactic, we might have some chance of preventing the disease. Experiments are necessary to prove what efficacy this drug would have in this direction.

Attention to the purity of the water-supply and giving hay only from localities known to be free from surra should be scrupulously carried out.

Measures to be adopted with regard to animals suffering.—Although we are led to believe that this disease is not contagious in the ordinary acceptation of the term, yet, as has been shown, there may under certain circumstances be some danger, and under these circumstances it appears to be not only advisable but necessary to take such precautions as would render contagion an impossibility. We consider, then, that the ordinary precautions adopted in regard to isolation of the sick, the cleansing of buckets and standings, burial or cremation of carcases, should in all cases be carried out.

Slaughter.—There seems little necessity to legislate for the slaughter of animals suffering from the malady, but it is in all cases desirable, and moreover it is a saving to the owner, as the disease always has a fatal termination. It would appear advisable to legislate for the disposal of carcases, and burial would probably suffice. We do not yet know for how long a time the débris remains virulent, but probably it does so for some time, and it is consequently of importance to remove it from the reach of healthy animals.

SUPPLEMENTAL NOTE BY DR. LINGARD.

As the Civil Veterinary Department are now issuing a résumé of my Report on Horse Surra in the Ledger Series, with the intention of circulating the same, before the whole question of the disease as it relates to other animals has been published, a few important facts are now added to throw additional light upon the probable way in which the disease is acquired by equines.

It has been known for some years that infusorian, resembling somewhat those found in the blood of horses suffering from surra, infest a large percentage of rats (*Mus decumanus*) in other countries as well as India; but proof was wanting that these organisms were capable of producing surra when blood containing them was subcutaneously injected into horses.

As early as January 1891, however, I made several experiments for the purpose of deciding the above question, and obtained positive results, but found that the periods of incubation were very long—in one case being as much as 63 days. Notwithstanding this, the virulence of the disease, when once developed, was intense, as shown by the short period during which the animal survived after the appearance of the hæmatozoon in the blood; this being in several cases only 2 to 5 days. This raised

the question as to how rats could cause the disease in horses for the food would rarely, if ever, be soiled with the blood of these animals. It therefore only remained to be tried whether the excreta of rats—in whose blood the infusorian was present at the time of its collection—could cause the disease when mixed with grain. In 1892, experiments were undertaken at Poona on the Deccan plateau, where the disease is not enzootic, and where the difficulty of producing it was fully recognised on account of the dryness of the situation; these, as expected, proved negative. At a later date—during the latter half of the hot season and the rains of 1893—further experiments with the same end in view were carried out in Bombay, where the climate is favourable from its humidity, and the disease is enzootic. From these, positive results were obtained, which points to the probability of a number of the surra cases in Bombay being contracted through the ingestion of rats' excreta mixed with the corn.

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